Announcements

Homework for tomorrow…

Ch. 22, Probs. 30, 32, & 49

CQ2: a) & c)

22.10: 43.2°

22.12: 0.142 m

22.14: 396 nm

- Office hours…

  MW 10-11 am

  TR 9-10 am

  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm

  F 8-11 am, 2-5 pm

  Su 1-5 pm

Chapter 22

Wave Optics

(Single-Slit Diffraction)

Last time…

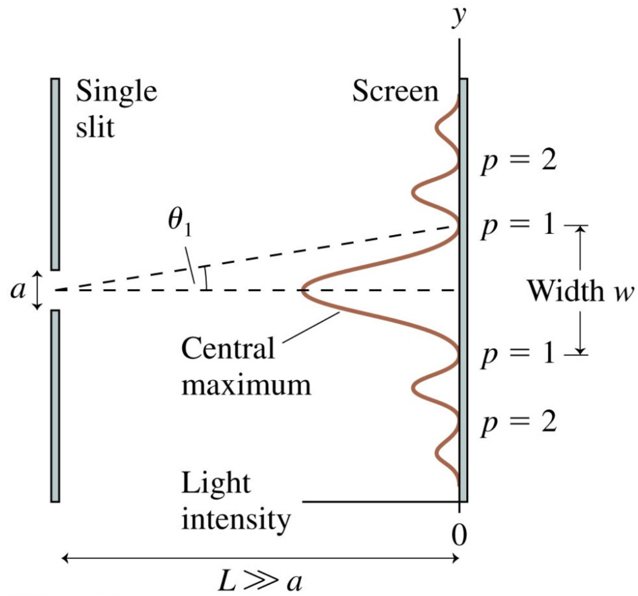
- The *intensity* of the bright fringes of the *diffraction grating*…

$$\boxed{I_{max} = N^2 I_1}$$

N = # of Slits

- The *dark fringes* of *single-slit diffraction* occur at *angular positions*…

$$\boxed{\theta_p = p\frac{\lambda}{a}} \quad , \quad p = 1, 2, 3, \ldots$$



i.e. 22.4: Diffraction of a laser through a slit

Light from a helium-neon laser (λ = 633 nm) passes through a narrow slit and is seen on a screen 2.0 m behind the slit. The first minimum in the diffraction pattern is 1.2 cm from the central maximum.

How wide is the slit?

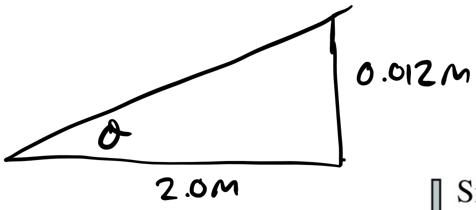
$\lambda = 633 \times 10^{-9}\,m$

$L = 2.0\,m$

$\theta = p\frac{\lambda}{a}$

$p = 1 \qquad a = \frac{p\lambda}{\theta_1}$

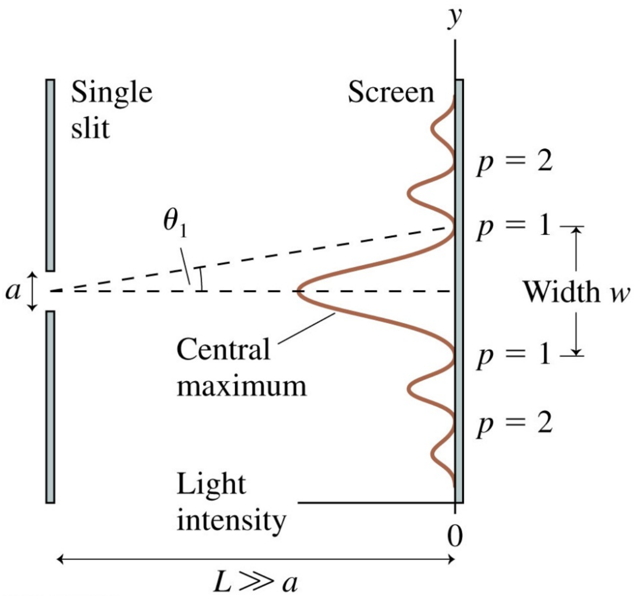
$a = 1.1 \times 10^{-4}\,m$



$\tan\theta = \left(\frac{0.012m}{2.0m}\right)$

$\theta = 0.343^\circ$

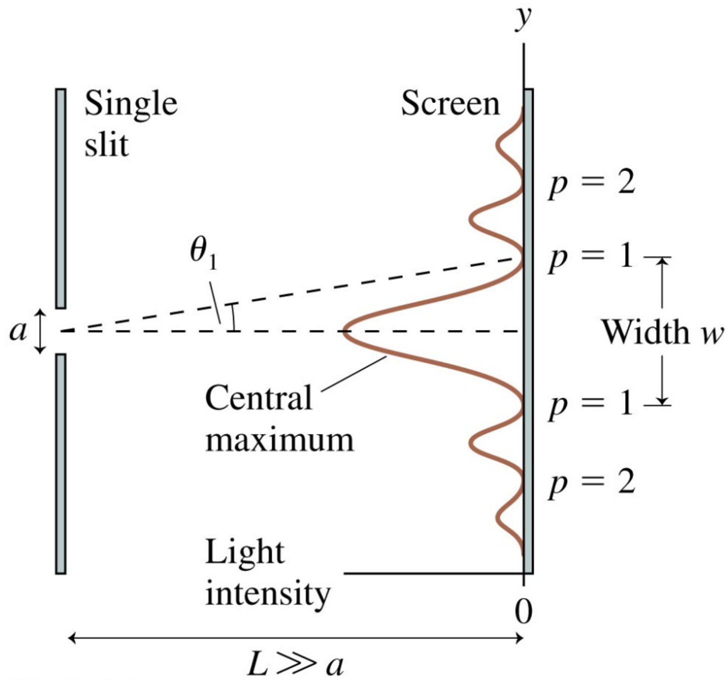
$\theta_1 = 6.0 \times 10^{-3}$ rads



The Width of a Single-Slit Diffraction Pattern…

The *angular positions* of the *dark fringes* in the interference pattern are..

$$\boxed{\theta_p = p\frac{\lambda}{a}} \quad , \qquad p = 1, 2, 3, \ldots$$

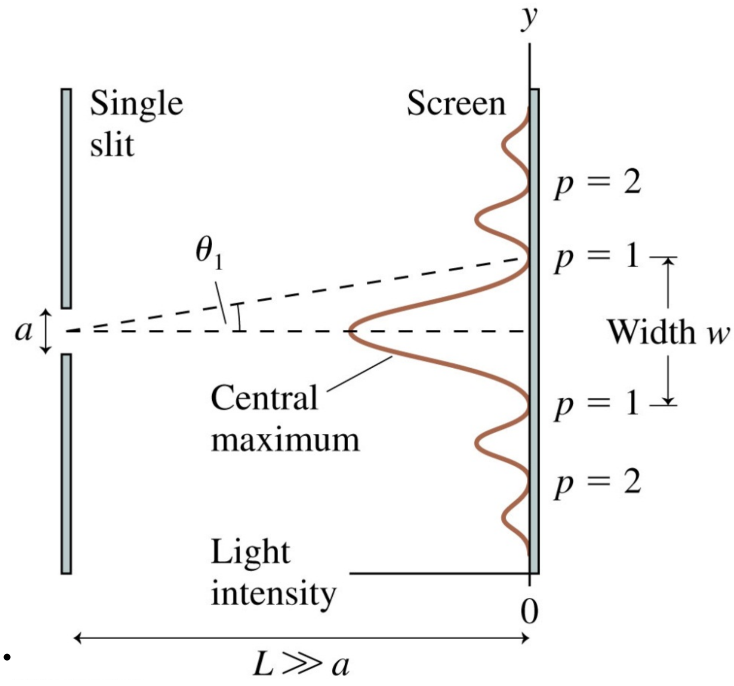


Where does the p^{th} dark fringe occur?

The Width of a Single-Slit Diffraction Pattern…

The *angular positions* of the *dark fringes* in the interference pattern are..

$$\boxed{\theta_p = p\frac{\lambda}{a}} \quad , \qquad p = 1, 2, 3, \ldots$$



Where does the p^{th} dark fringe occur?

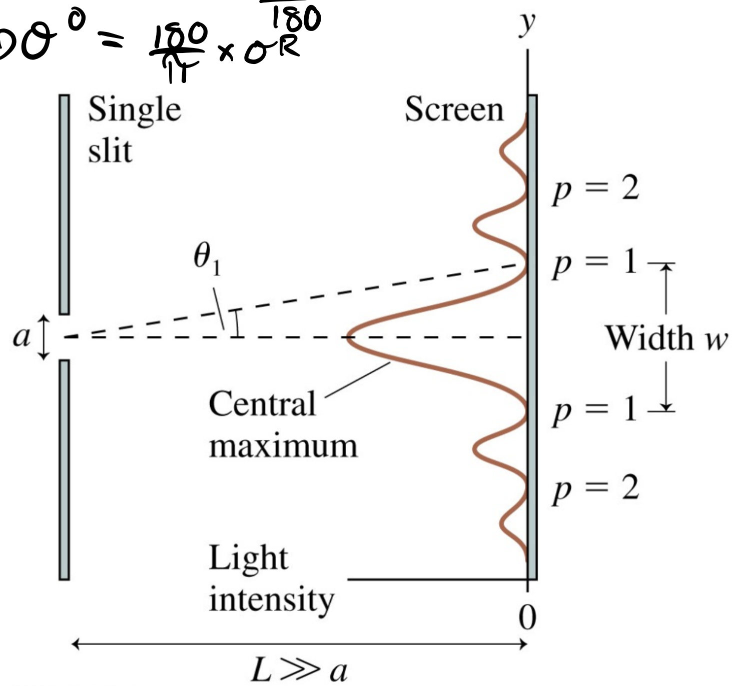
$$\boxed{y_p = \frac{p\lambda L}{a}} \quad , \qquad p = 1, 2, 3, \ldots$$

The Width of a Single-Slit Diffraction Pattern…

What is the *width* of the *central maximum*?

$\theta^{\circ} \to \theta^{R} = \theta^{\circ} \times \frac{\pi}{180}$

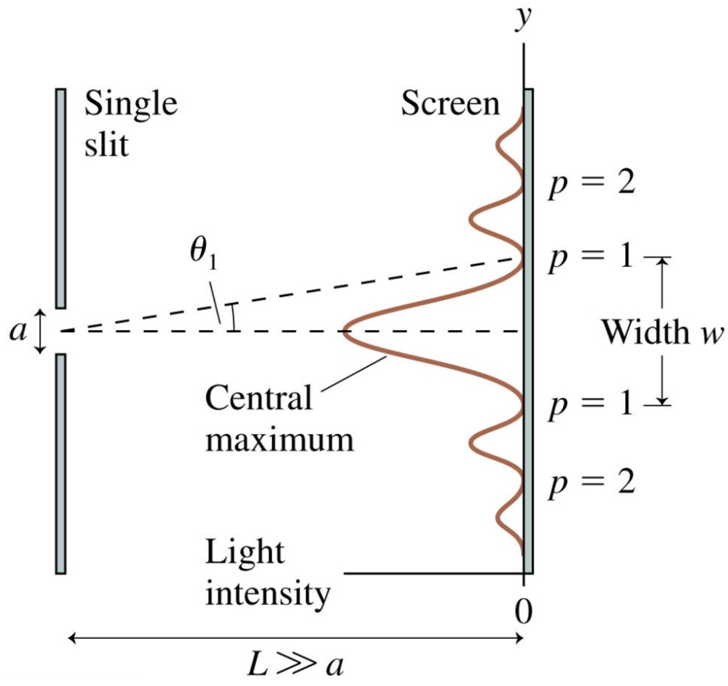
$\theta^{R} \to \theta^{\circ} = \frac{180}{\pi} \times \theta^{R}$



The Width of a Single-Slit Diffraction Pattern…

What is the *width* of the *central maximum*?

$$\boxed{w = \frac{2\lambda L}{a}}$$



Notice:

- The *width* of the *central maximum* is *twice* the spacing between the dark fringes on either side.
- The *smaller* the opening you squeeze a wave through, the *more* it spreads out on the other side.

i.e. 22.5: Determining the wavelength

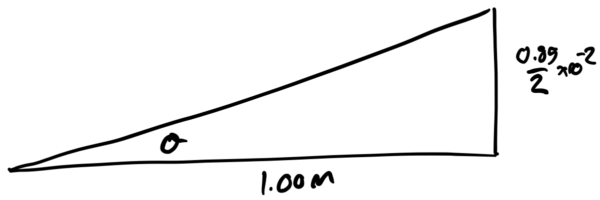
Light passes through a 0.12 mm wide slit and forms a diffraction pattern on a screen 1.00 m behind the slit. The width of the central maximum is 0.85 cm.

What is the wavelength of light?

$a = 0.12\ mm$

$L = 1.00\ m$

$h = \frac{0.85}{2}\ cm$



$\theta = \tan^{-1}\left(\frac{y}{x}\right)$

$\theta = 0.004^{\circ}$

$$W = \frac{2\lambda L}{a}$$

$$\frac{Wa}{2L} = \lambda$$

Quiz Question 1

A laboratory experiment produces a single-slit diffraction pattern on a screen. The slit width is a and the light wavelength is λ. In this case,

1. $\lambda < a$.
2. $\lambda = a$.
3. $\lambda > a$.
4. Not enough info to compare λ to a.